



Using Nuclide Mixtures in Nucleonica

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Nuclide Mixtures:

- Why mixtures ?
 - Mixture vs. simple nuclide
 - in the real life: mainly mixtures
 - Mixture vs. Compound
 - Nuclear properties are independent from chemical bonds
- Often used module in other applications

Mixtures in Nucleonica



1. Nuclide mixtures overview e.g. U232+Co60
2. Case study with natural uranium
3. Exercise

Go to Nuclide Mixtures

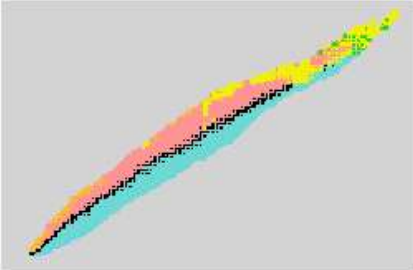


Logged in as: rdf Networking **Nuclear Science** Search Forum Calculator Privacy Legal Logout

nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Help New Alerts

> Nuclide Explorer



>> Actual Chart: Karlsruhe

> Search Nucleonica Documentation

Nuclear Data Retrieval

> Application Centre

- >> Mass Activity Calculator
- >> Decay Engine
- >> Dosimetry & Shielding
- >> Range & Stopping Power
- >> webKORIGEN
- >> Universal Nuclide Chart
- >> Transport & Packaging
- >> Nuclide mixtures**
- >> Nucleonica Scripting
- >> Library creation for 3rd party software
- >> Gamma Spectrum Generator
- >> Gamma Spectrum Generator Pro
- >> easy Monte Carlo
- >> Cambio file Converter
- >> Extended Graph Module

> Data Centre

Welcome, F.Ray

[My Settings](#)
[Networking](#)

> My Last Nuclides

- 92 U235
- 92 U238
- 36 Kr81 m
- 37 Rb81
- 55 Cs137

> My Nuclide Mixtures

- U232+Co60**
- Decay of 1 Grams of 37 Rb 81 after 10 Hours
- Transuranics in 1 ton Spent Fuel
- Natural Uranium
- Natural Thorium

> My Sources


> My Messages

Nuclide mixtures: User Interface...





























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Applications Data Knowledge My Preferences Print Help New Browser

 **Nuclide Mixtures** [Getting started](#) [Reference manual](#)

My Mixtures Edit Upload Sample Mixtures

User defined nuclide mixtures

ID	Mixture	Date modified ▼	Download	Delete
<i>(create, upload a new Mixture)</i>				
8500	Vincenzo@KIT	03.02.2011, 12:47:50		
8486	Uranium Ore	02.02.2011, 14:11:34		
8485	Decay of 100 Grams of 92 U 238 after 4.46808e+10 Years(0.01)	02.02.2011, 14:10:47		
7930	Rb-81/Kr-81m Generator	06.01.2011, 17:11:10		
7522	1 ton Spent Fuel with thorium	07.12.2010, 09:48:16		
5739	isobar mass number 99	11.09.2010, 16:47:35		
4477	Natural Uranium	08.04.2010, 15:50:06		
4474	Pu-Be 2007 six isotopes	20.03.2010, 07:51:56		
4478	Transuranics in 1 ton Spent Fuel	10.03.2010, 14:31:18		
4479	U232+Co60	10.03.2010, 13:50:08		
4476	Natural Thorium	10.03.2010, 13:36:26		
4475	Cs137 + Ba137m	10.03.2010, 13:31:00		
All Mixtures (12)				

Create a new nuclide mixture....



nucleonica ... web driven nuclear science

Applications Data Knowledge My Preferences Print Help New Browser

Nuclide Mixtures

Getting started
Reference manual

My Mixtures Edit Upload Sample Mixtures

Name
enter the name of the mixture

Description:
give a short description of the mixture

Nuclide	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>							
63 Eu 152	7.000e+6	1.087e-6	4.310e+15	0.4079	0.3785	0.5385	
55 Cs 137	5.000e+6	1.555e-6	6.838e+15	0.5832	0.6005	0.3846	
27 Co 60	1.000e+6	2.388e-8	2.400e+14	8.959e-3	0.02107	0.07692	
Total: 3	1.300e+7	2.666e-6	1.139e+16	1	1	1	

Significant figures: 4

Element Mass Quantity Unit

Ga 82 1 Gram

Update

Save Mixture Reset Cancel Save as Sample

Gram
Becquerel
Curie
Number of Atoms
Mole



Nuclide Mixtures

Example: natural uranium

My Mixtures Edit Upload Sample Mixtures

Name

Description:

Nuclide ▲	Activity(Bq)	Mass(g)	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>						
92 U 234	2.907e+6	0.01264	5.310e-5	5.400e-5	0.4860	
92 U 235	1.354e+5	1.693	7.114e-3	7.204e-3	0.02264	
92 U 238	2.939e+6	236.3	0.9928	0.9927	0.4913	
Total: 3	5.981e+6	238.0	1.000	1	1	

Significant figures:

Nuclide Mixtures: Pre-defined Mixtures



My Mixtures Edit Upload **Sample Mixtures**

Select	Sample Mixture Name	Date Modified
<input checked="" type="checkbox"/>	Cs137 + Ba137m	10.03.2010, 13:31:00
<input checked="" type="checkbox"/>	Natural Thorium	10.03.2010, 13:36:26
<input checked="" type="checkbox"/>	Natural Uranium	08.04.2010, 15:50:06
<input checked="" type="checkbox"/>	Transuranics in 1 ton Spent Fuel	10.03.2010, 14:31:18
<input checked="" type="checkbox"/>	U232+Co60	10.03.2010, 13:50:08


Send to My Mixtures

Create a new mixture:

Details



1. In Edit, enter a **name** for the mixture
2. Enter short description
3. Enter components → „(add a new nuclide)“
 - Choose a nuclide
 - Select a unit
 - Enter the quantity
 - Update grid
4. Save the mixture



Nuclide Mixtures

[Getting started](#)
[Reference manual](#)

My Mixtures

Edit

Upload

Sample Mixtures

Name

my highly enriched uranium, HEU

Description:

isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.

Nuclide ▲	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
(add a new Nuclide)							
Total: 0	0	0	0	0	0	0	

Significant figures: 4 ▼

Element

Mass

Quantity

Unit

Update

Save Mixture

Reset

Cancel

Create a new mixture:

Details



My Mixtures Edit Upload Sample Mixtures

Name

my highly enriched uranium, HEU

Description:

isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.

Nuclide ▲	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>							
92 U 238	4.277e-17	3.439e-21	8.700	0.08802	0.087	5.940e-4	
92 U 236	3.058e-16	1.293e-22	0.33	3.310e-3	3.300e-3	4.248e-3	
92 U 235	2.815e-15	3.521e-20	90.20	0.9010	0.902	0.03910	
92 U 234	6.883e-14	2.992e-22	0.7700	7.659e-3	7.700e-3	0.9561	
Total: 4	7.200e-14	3.907e-20	100.0	1	1	1	

Significant figures:

Element

Mass

Quantity

Unit

Update

Save Mixture

Reset

Cancel

Create a new mixture: Save & Download mixture



My Mixtures Edit Upload Sample Mixtures

Name
my highly enriched uranium, HEU

Description:
isotopic composition: 0.77% U-234, 90.20% U-235,

Nuclide	Activity(Bq)	Mass(g)	Number of Atoms
(add a new Nuclide)			
92 U 234	1.762e+6	7.659e-3	1.971e+19
92 U 235	7.205e+4	0.9010	2.309e+21
92 U 236	7.827e+3	3.310e-3	8.446e+18
92 U 238	1.095e+3	0.08802	2.227e+20
Total: 4	1.843e+6	1	2.559e+21

Element Mass Quantity Unit
[] [] 1 [g]

Save Mixture Reset Cancel

My Mixtures Edit Upload Sample Mixtures

User defined nuclide mixtures

Mixture	Date modified	Download	Delete
(create, upload a new Mixture)			
my highly enriched uranium, HEU	06.05.2011, 14:13:37		
HEU, highly enriched uranium	06.05.2011, 13:32:54		
My Uranium			
My U232+Co60 Mixture			
Natural Uranium			
Decay of 1 Grams of 3			
U232+Co60			
Transuranics in 1 ton			
Natural Thorium			
Cs137 + Ba137m			
All Mixtures (10)			

File Download

Save As

Save in: Mixtures

- Mixture_my highly enriched uranium, HEU.xml
- Mixture_Natural Uranium.xml
- Mixture_UO2 six.xml
- Mixture_UO2 with 3 oxygen isotopes.xml
- Mixtures_All(2).xml
- Mixtures_All(3).xml
- Mixtures_All.xml
- Mixtures_All_rdf.xml

File name: Mixture_my highly enriched uranium, HEU.xml

Save as type: XML Document

Save Cancel



Case Study: Natural Uranium

Create a nuclide mixture for 100 g uranium

Hint 1: Create a nuclide mixture for 100 atoms of uranium using the isotopic abundancies of natural uranium from Nuclide Datasheets or from Nuclide explorer

Hint 2: Use rescale feature to transform from 100 atoms to 100 g

	U234 0.0054	U235 0.7204	U236 2.4E7 y	U237 6.75 d	U238 99.2742	
	2.5E5 y	26 m	7.0E8 y		4.5E9 y	
	Pa233 27 d	Pa234	Pa235 24.2 m	Pa236 9.1 m	Pa237 8.7 m	

Case Study: Natural Uranium



My Mixtures Edit Upload Sample Mixtures

Name
My natural Uranium

Description:
My natural Uranium:
99.2742 atom% U238
0.7204 atom% U235
0.0054 atom% U234

Nuclide	Activity(Bq)	Mass(g)	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>						
Total: 0	0	0	0	0	0	

Element Mass Quantity Unit

U 238 99.2742 Number of Atoms

Update

Save Mixture Reset Cancel

Nuclide Database
92 Uranium
Current Chart: Karlsruhe

U238
99.2742
4.5E9 y

Element: Mass:
U 238

Reference Data Description Derived Data Cross Section

» Reference Data Notes

Density	19.1 g/cm ³
Mass Excess	47308.948 (± 1904) keV
Atomic Mass	238.050788247 (± 2044) u
Half-life	4.468 (± 3) Gy
Spin	0 ħ
Parity	+
Binding Energy	7.57012 MeV/nucleon
Abundance	99.2742 (± 10) atom %

Case study: Add Uranium components



My Mixtures Edit Upload Sample Mixtures

Name
My natural Uranium

Description:
My natural Uranium:
99.2742 atom% U238
0.7204 atom% U235
0.0054 atom% U234

Nuclide ▲	Activity(Bq)	Mass(g)	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>						
92 U 235	2.24826e-17	2.81172e-22	7.11404e-3	7.20439e-3	0.0440393	
92 U 238	4.88029e-16	3.92424e-20	0.992886	0.992796	0.955961	
Total: 2	5.10512e-16	3.95235e-20	1	1	1	

Element Mass Quantity Unit

U 235 0.7204 Number of Atoms

U235
0.7204

26 m 7.0E8 y

Nuclide Data

92 Uranium

Current Chart: Karlsruhe

Element: Mass:

U 235

Reference Data Description Derived Data 0

» Reference Data Notes

Density	19.1 g/cm ³
Mass Excess	40920.456 (± 1823) keV
Atomic Mass	235.043929918 (± 1957) u
Half-life	703.8 (± 5) My
Spin	7/2 ħ
Parity	-
Binding Energy	7.59091 MeV/nucleon
Abundance	0.7204 (± 6) atom %

Case Study: Add Uranium components



My Mixtures Edit Upload Sample Mixtures

Name
My natural Uranium

Description:
My natural Uranium:
99.2742 atom% U238
0.7204 atom% U235
0.0054 atom% U234

Nuclide ▲	Activity(Bq)	Mass(g)	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>						
92 U 234	4.8273660e-16	2.0986240e-24	5.3095279e-5	5.4000000e-5	0.48601799	
92 U 235	2.2482608e-17	2.8117180e-22	7.1136589e-3	0.007204	0.022635433	
92 U 238	4.8802922e-16	3.9242353e-20	0.99283325	0.992742	0.49134658	
Total: 3	9.9324843e-16	3.9525624e-20	1	1	1	

Element Mass Quantity Unit

Nuclide Data
92 Uranium

Current Chart: Karlsruhe

Element: Mass:

Reference Data Description Derived Data

» **Reference Data Notes**

Density	19.1 g/cm ³
Mass Excess	38146.625 (± 1827) keV
Atomic Mass	234.040952088 (± 1960)
Half-life	245.7 (± 3) ky
Spin	0 ħ
Parity	+
Binding Energy	7.60071 MeV/nucleon
Abundance	0.0054 (± 5) atom %

Rescale Feature:

„Total“ rescaled to 100 g



My Mixtures Edit Upload Sample Mixtures

Name
My natural Uranium

Description:
My natural Uranium:
99.2742 atom% U238
0.7204 atom% U235
0.0054 atom% U234

Nuclide ▲	Activity(Bq)	Mass(g)	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>						
92 U 234	1.2213257e+6	5.3095279e-3	5.3095279e-5	5.4000000e-5	0.48601799	🗑
92 U 235	5.6881097e+4	0.71136589	7.1136589e-3	7.2040000e-3	0.022635433	🗑
92 U 238	1.2347160e+6	99.283325	0.99283325	0.992742	0.49134658	🗑
Total: 3	2.5129228e+6	100	1	1	1	🗑

Significant figures: 8 ▼

Element Mass Quantity Unit

Case study: Atomic weight of U



My Mixtures Edit Upload Sample Mixtures

Name
My natural Uranium

Description:
My natural Uranium:
99.2742 atom% U238
0.7204 atom% U235
0.0054 atom% U234

Nuclide ▲	Activity(Bq)	Mass(g)	Mass ratio	Mole ratio	Activity ratio	Delete
<i>(add a new Nuclide)</i>						
92 U 234	2.9071083e+6	0.012638211	5.3095279e-5	5.4000000e-5	0.48601799	
92 U 235	1.3539346e+5	1.6932565	7.1136589e-3	0.007204	0.022635433	
92 U 238	2.9389812e+6	236.32302	0.99283325	0.992742	0.49134658	
Total: 3	5.9814829e+6	238.02891	1.0000000	1	1	

Significant figures: 8 ▼

Element Mass Quantity Unit
[dropdown] [dropdown] 1 Mole [dropdown] Update

Save Mixture Reset Cancel

Comparing with Karlsruhe Nuclide Chart: 238.02891



Mixtures in Nucleonica

1. Nuclide mixtures overview e.g. $U^{232}+Co^{60}$
2. Case study with natural uranium
3. Exercise

ITRAC-3: 3th Training Course on Illicit Trafficking and Radiological Consequences with Nucleonica

Karlsruhe, 11th May 2011




Using Nuclide Mixtures in Nucleonica

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Nuclide Mixtures: Overview





Nuclide Mixtures

My Mixtures Edit Upload Sample Mixtures

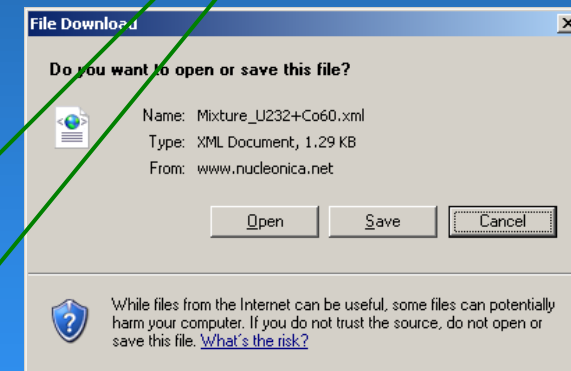
User defined nuclide mixtures

Mixture	Date modified	Download	Delete
<i>(create, upload a new Mixture)</i>			
Natural Uranium	09.04.2010, 14:13:22		
Decay of 1 Grams of 37 Rb 81 after 10 Hours	09.04.2010, 10:43:21		
Transuranics in 1 ton Spent Fuel	10.03.2010, 14:31:18		
U232+Co60	10.03.2010, 13:50:08		
Natural Thorium	10.03.2010, 13:36:26		
Cs137 + Ba137m	10.03.2010, 13:31:00		
All Mixtures (6)			

Sorted by Date,
descending order

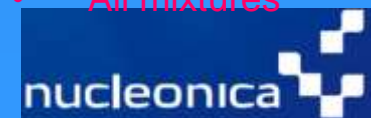
Download (as XML file)

- This mixture
- All mixtures



Delete

- This mixture
- All mixtures



Upload Nuclide Mixtures



My Mixtures Edit Upload Sample Mixtures

Browse a file to be uploaded:

Browse...

Upload File Reset

Uploaded file: Mixture_Natural Uranium.xml

1 Mixture, 3 Components added, 1 Mixture deleted, 0 Error.

```
<?xml version="1.0" encoding="UTF-8"?>
<Nucleonica_Mixture>
  <Information>
    <Site>www.nucleonica.net</Site>
    <Application>Nuclide Mixtures</Application>
    <Version>2.0.32.1</Version>
    <Created_By>rdf</Created_By>
    <FileDescription>Nuclide mixture with the mass in gram of
    <DownloadDate>09/Apr/2010 14:13:35</DownloadDate>
  </Information>
  <Units>
    <Mass>g</Mass>
    <Time>s</Time>
    <Activity>Bq</Activity>
  </Units>
  <Mixture>
    <MixtureName>Natural Uranium</MixtureName>
    <MixtureDescription>Natural Uranium, 99.2742% U238, 0.7
    <Mass>238.028910308445</Mass>
    <Activity>5981477.90387284</Activity>
```

Choose file

Look in: Mixtures

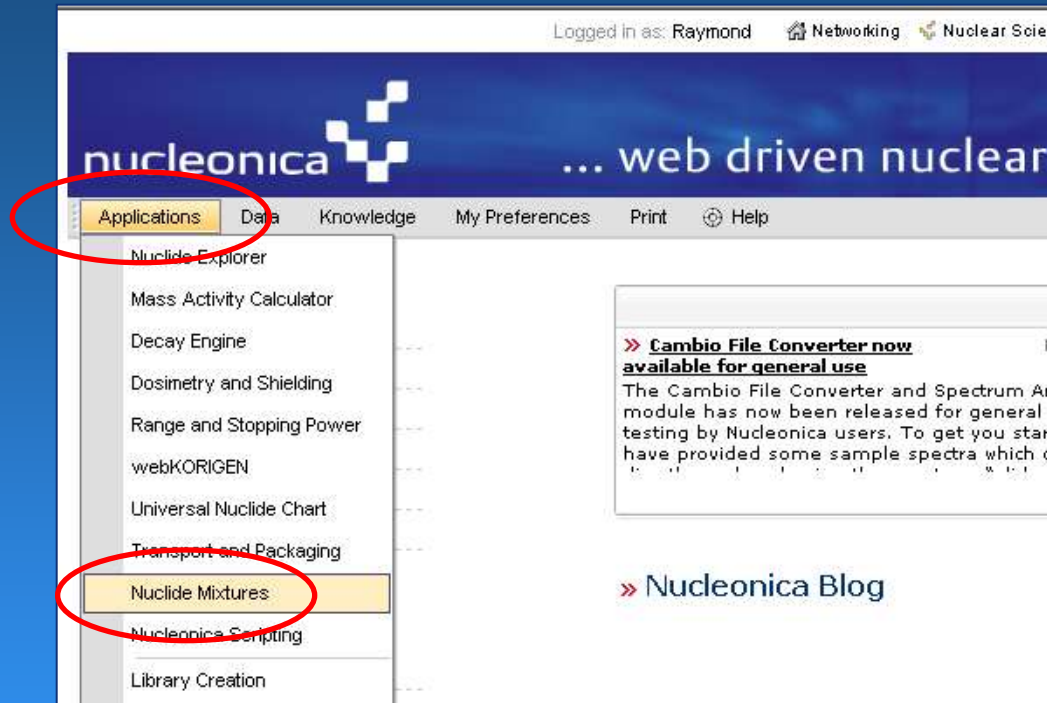
- Mixture_Natural Uranium.xml
- Mixture_ttttt.xml
- Mixture_UO2 six.xml
- Mixture_UO2 with 3 oxygen isotopes.xml
- Mixtures_All(2).xml
- Mixtures_All(3).xml
- Mixtures_All.xml
- Mixtures_All_rdf.xml

File name: Mixture_Natural Uranium.xml

Files of type: All Files (*.*)

Open Cancel

Go to Nuclide Mixtures



Create a new mixture:

Details



My Mixtures Edit Upload Sample Mixtures

Name

my highly enriched uranium, HEU

Description:

isotopic composition: 0.77% U-234, 90.20% U-235, 0.33% U-236 and 8.7% U-238.

Nuclide ▲	Activity(Bq)	Mass(g)	Number of Atoms	Mass ratio	Mole ratio	Activity ratio	Delete
(add a new Nuclide)							
92 U 236	3.058e-16	1.293e-22	0.33	3.630e-3	3.614e-3	4.250e-3	🗑
92 U 235	2.815e-15	3.521e-20	90.20	0.9880	0.9880	0.03912	🗑
92 U 234	6.883e-14	2.992e-22	0.7700	8.398e-3	8.434e-3	0.9566	🗑
Total: 3	7.196e-14	3.563e-20	91.30	1	1	1	🗑

Significant figures: 4 ▼

Element

Mass

Quantity

Unit

U ▼

238 ▼

8.7

Number of Atoms ▼

Update

Save Mixture

Reset

Cancel

Gram

Becquerel

Curie

Number of Atoms

Mole

nucleonica

Create a new mixture: Save & Download mixture



My Mixtures Edit Upload Sample Mixtures

Name
My U232+Co60 mixture

Description:
1g U232+Co60







Nuclide	Activity(Bq)	Mass(g)	Mass
(add a new Nuclide)			
27 Co 60	2.512e+13	0.6	0.6
92 U 232	3.267e+11	0.4	0.4
Total: 2	2.545e+13	1	1

Element Mass Quantity

Save Mixture Reset

My Mixtures Edit Upload Sample Mixtures

User defined nuclide mixtures

ID	Mixture	Date modified	Download	Delete
(create, upload a new Mixture)				
11421	My U232+Co60 mixture	06.05.2011, 11:38:27		
11420	enter the name of the mixture	06.05.2011, 11:36:01		
8506	Vincenzo@KIT	03.02.2011, 12:47:50		
8486	Uranium Ore			
8485	Decay of 100 Grams of 92 U 238 after 4.4			
7930	Rb-81/Kr-81m Generator			
7522	1 ton Spent Fuel with thorium			
5739	isobar mass number 99			
4479	U232+Co60			
4478	Transuranics in 1 ton Spent Fuel			
4477	Natural Uranium			
4476	Natural Thorium			
4475	Cs137 + Ba137m			
4474	Pu-Be 2007 six isotopes			
All Mixtures (14)				

Choose file

Look in: Mixtures

- Mixture_Natural Uranium.xml
- Mixture_tttt.xml
- Mixture_UO2 six.xml
- Mixture_UO2 with 3 oxygen isotopes.xml
- Mixtures_All(2).xml
- Mixtures_All(3).xml
- Mixtures_All.xml
- Mixtures_All_rdf.xml

File name: Mixture_Natural Uranium.xml

Files of type: All Files (*.*)

Open Cancel